

AMENDMENT OF PROCEEDINGS

(Amendment in accordance with Article 11)

To the Patent Examiner, Japan Patent Office

1. International application identification:

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4. Parts amended: Claims

5. Content of the amendment

(1) Line 3 of claim 1 has been amended from "space is formed between the electron emitting elements" to "the electron emitting elements are made independent and space is formed therebetween".

(2) Line 1 of claim 5 has been changed from "the lower electrode and the upper electrode connected at the bridge portions" to "both the lower electrode, and the upper electrode connected at the bridge portions".

(3) Line 12 of claim 17 has been changed from "etching part of the exposed insulator layer to or near to the substrate and lower electrode by anisotropic etching using the bridge portions as a mask" to "etching part of the exposed insulator layer by anisotropic etching, and either etching the substrate and lower electrode, or in subsequently carried out isotropic etching, etching the substrate and the lower electrode as far as the part that can be exposed, using the bridge portions as a mask".

(4) Lines 4 - 5 of claim 22 have been changed from "and a canopy-shaped structure made from the material of the insulator layer is formed in the through holes projecting towards the center of the through holes" to "in the through holes or notches bridge portions are formed comprising the material part of the insulator layer, and a canopy-shaped structure made from the material of the insulator layer is formed in the through holes or notches projecting towards the center of the through holes or the inside of the notches".

6. List of attachments

(1) Claims, pages 31, 33, 33/1, 34, 35, 35/1

CLAIMS

1. (After amendment) An electron emitting device having a lower electrode near a substrate and an upper electrode far from the substrate respectively, formed of a plurality of electron emitting elements which emit electrons from a side of the upper electrode, characterized in that the electron emitting elements are made independent and in that space is formed therebetween, and in that the upper electrode extends across the plurality of electron emitting elements and the space by a bridging portion of the upper electrode.

2. The electron emitting device according to claim 1, wherein the bridge portion is provided with at least one through hole or notched portion.

3. The electron emitting device according to claim 2, wherein the through hole or notched portion is circular-shaped, rectangular-shaped, diamond-shaped, barrel-shaped, star-shaped, shoulder drum shaped, or a shape formed of part of these shapes.

4. The electron emitting device according to any of claims 1 to 3, wherein the bridge portion extends approximately parallel to the substrate.

5. (After amendment) The electron emitting device according to any of claims 1 to 4, wherein both the lower electrode, and the upper electrode connected at the bridge portions are stripe shaped electrodes arranged in positions that are mutually orthogonal.

6. The electron emitting device according to any of claims

1 to 4, wherein the upper electrode extends over a plurality of electron emitting elements and spaces by the bridge portions without the electron emitting elements being limited to the row or column directions, and the lower electrode is separated and independent for each electron emitting element.

7. The electron emitting device according to claim 5 or claim 6, wherein the electron emitting elements further comprise an insulator layer and an electron supply layer made from a semiconductor deposited between the lower electrode and the upper electrode, and when a voltage is applied between the lower electrode and the upper electrode electrons are emitted from the upper electrode.

8. The electron emitting device according to claim 7, wherein the bridge portion comprises the material of the insulator layer that is integral with the insulator layer of the electron emitting element.

9. The electron emitting device according to any of claims 1 to 8, wherein the electron supply layer is made from an amorphous phase that comprises silicon or a mixture or compound whose main component is silicon.

10. The electron emitting device according to any of claims 1 to 9, further comprising at least one electron emitting section formed from an island area in which the film thickness of the insulator layer and the upper electrode gradually decrease towards the electron supply layer.

11. The electron emitting device according to claim 10, wherein in the island areas the upper electrode terminates on the insulator

layer.

12. The electron emitting device according to claim 10 or claim 11, wherein in the island areas the insulator layer terminates on the electron supply layer.

13. The electron emitting device according to any of claims 10 to 12, wherein the island areas are depressions in the flat surface of the upper electrode.

14. The electron emitting device according to any of claims 10 to 13, wherein the insulator layer is made from dielectric material, and a part other than the island areas has a film thickness of 50 nm or greater.

15. The electron emitting device according to any of claims 10 to 14, wherein electrically insulating masks are provided in the island areas.

16. The electron emitting device according to any of claims 10 to 15, wherein a carbon area comprising carbon or a mixture with carbon as a component or a carbon compound is provided in the top, bottom, or middle of the island areas.

17. (After amendment) A method of manufacturing an electron emitting device having a lower electrode near a substrate and an upper electrode far from the substrate respectively, formed of a plurality of electron emitting elements which emit electrons from a side of the upper electrode, with space being formed between the electron emitting elements, and the upper electrode being extending across the plurality of electron emitting elements and the space by a bridging portion of the upper electrode, the method characterized by comprising:

an electron emitting section forming step of forming a laminated body on which an upper electrode material layer is deposited to form a plurality of electron emitting elements on a substrate;

a bridge forming step of forming a plurality of bridge portions provided with at least one through hole or notch along a line that separates the plurality of electron emitting elements by etching the upper electrode material layer;

a cutting step of etching part of the exposed insulator layer by anisotropic etching, and either etching the substrate and lower electrode, or in subsequently carried out isotropic etching, etching the substrate and the lower electrode as far as the part that can be exposed, using the bridge portions as a mask; and

a separating step of separating the exposed part of the insulator layer into the plurality of electron emitting elements by etching by isotropic etching to enlarge the space using the bridge portions as a mask.

18. The method of manufacturing an electron emitting element according to claim 17, wherein in the cutting step mixed gas comprising CH_2F_2 , SF_6 , Cl_2 is brought into contact with the exposed part of the insulator layer.

19. The method of manufacturing an electron emitting element according to claim 17 or 18, wherein in the separating step mixed gas comprising CF_4 is brought into contact with the exposed part of the insulator layer.

20. The method of manufacturing an electron emitting element according to any of claims 17 to 19, wherein the electron emitting section forming step comprises:

an electron supply layer forming step of forming an electron supply layer comprising silicon or a mixture whose main component is silicon or a silicon compound on the substrate;

a mask forming step of forming a mask that forms a canopy around the portion in contact with the electron supply layer on the electron supply layer;

an insulator layer forming step of forming an insulator layer formed from a thin film of insulation material by depositing insulation material on the electron supply layer and the mask, so that around the part in contact with the mask the film thickness of the insulator layer gradually decreases to form at least one island area; and

an upper electrode forming step of forming a film of the upper electrode on the insulator layer to form the island area as an electron emitting section.

21. The method of manufacturing according to claim 20, further comprising a carbon area forming step of forming a carbon area comprising carbon or a mixture with carbon as a component or a carbon compound in the top, bottom, or middle of the island areas.

22. (After amendment) The electron emitting device according to claim 20 or claim 21, wherein in the bridge forming step the upper electrode and the insulator layer are etched by the isotropic etching method to form bridge portions including the material part of the insulator layer integral with the insulator layers and upper electrodes of adjacent electron emitting elements, in the through holes or notches bridge portions are formed including the material part of the insulator layer, and a canopy-shaped

structure made from the material of the insulator layer is formed in the through holes or notches projecting towards the center of the through holes or the inside of the notches.

23. The method of manufacturing according to any of claims 20 to 22, wherein the masks are micro masks comprising a support portion that project in a direction normal to the substrate and a main mask that projects in a direction parallel to the substrate from the support portion, and the mask forming step comprises the steps of:

forming a support portion material layer and a main mask material layer on the substrate;

forming a resist mask thereon by photolithography so that at least part of the electron supply layer is exposed; and

etching the main mask and the support portion in that order by the dry etching method and the wet etching method to form the micro masks.

24. An imaging element, comprising:

an electron emitting device according to any of claims 1 to 16;

a photoelectric conversion film approximately parallel to and opposed to the upper electrode and enclosing a vacuum space; an optically transparent electrically conducting film deposited on the photoelectric conversion film; and

an optically transparent front substrate that supports the photoelectric conversion film and the optically transparent electrically conducting film.

25. The imaging element according to claim 24, further

comprising a mesh electrode arranged within the vacuum so as to not contact the electron emitting device of the photoelectric conversion film.

26. A display device comprising:
an electron emitting device according to any of claims 1 to 16;
and

an optically transparent front substrate in opposition to the upper electrode and enclosing a vacuum space, with a fluorescent layer arranged on the surface on the side of the vacuum space, and a collector electrode formed on the fluorescent layer and in opposition to the upper electrode.

27. The display device according to claim 26, having an image display array comprising a plurality of light emitters corresponding to the fluorescent layer.

請求の範囲

1. (補正後) 各々が基板に近い側の下部電極及び前記基板に遠い側の上部電
5 極を有し、前記上部電極側から電子を放出する複数の電子放出素子からなる電子
放出装置であって、前記電子放出素子同士が独立しその間に空間が形成されてお
り、前記上部電極は前記複数の電子放出素子に亘りかつ前記空間をそのブリッジ
部によって跨いで延在していることを特徴とする電子放出装置。
2. 前記ブリッジ部に少なくとも1つの貫通孔又は切欠部が設けられている
10 ことを特徴とする請求項1記載の電子放出装置。
3. 前記貫通孔又は切欠部は、円形、矩形、菱形、樽形、星形若しくは小鼓
形又はこれらを構成する一部の形状を有していることを特徴とする請求項2記
載の電子放出装置。
4. 前記ブリッジ部が前記基板に略平行に伸長している請求項1～3のいず
15 れかに記載の電子放出装置。
5. (補正後) 前記下部電極と、前記ブリッジ部で接続された前記上部電極と
は、それぞれストライプ状の電極でありかつ互いに直交する位置に配列されてい
ることを特徴とする請求項1～4のいずれかに記載の電子放出装置。
6. 前記上部電極は電子放出素子を列または行方向に限定することなく複数
20 の電子放出素子に亘りかつ前記空間を前記ブリッジ部によって跨いで延在し、前
記下部電極は電子放出素子毎に分離独立していることを特徴とする請求項1～
4のいずれかに記載の電子放出装置。

15. 前記島領域において電気絶縁性の遮蔽体を備えていることを特徴とする請求項10～14のいずれかに記載の電子放出装置。

16. 前記島領域の上部若しくは下部又は内部に、炭素又は炭素を成分とする混合物若しくは炭素化合物からなる炭素領域が設けられていることを特徴とする請求項10～15のいずれかに記載の電子放出装置。

17. (補正後) 各々が基板に近い側の下部電極及び前記基板に遠い側の上部電極を有し、前記上部電極側から電子を放出する複数の電子放出素子からなり、前記電子放出素子同士の間には空間が形成されており、前記上部電極は前記複数の電子放出素子に亘りかつ前記空間をそのブリッジ部によって跨いで延在している電子放出装置の製造方法であって、

基板上に前記複数の電子放出素子を構成するため上部電極の材料層が積層された積層体を形成する電子放出部形成工程と、

複数の電子放出素子に区切るべき線に沿って少なくとも1つの貫通孔又は切欠部が設けられた複数のブリッジ部を、エッチングによって前記上部電極の材料層から形成するブリッジ形成工程と、

前記ブリッジ部をマスクとして、露出した前記積層体の部分を異方性エッチングによって前記基板及び下部電極を食刻するか、又は後に行う等方性エッチングにおいて前記基板及び下部電極を露出できる部分まで食刻する切削工程と、

前記ブリッジ部をマスクとして、露出した前記積層体の部分を等方性エッチングによって食刻し空間を拡張して前記複数の電子放出素子に分離する分離工程と、を含むことを特徴とする電子放出装置の製造方法。

18. 前記切削工程において、 CH_2F_2 、 SF_6 、 Cl_2 を含む混合ガスを

露出した前記積層体の部分に接触させることを特徴とする請求項17記載の電

子放出素子の製造方法。

19. 前記分離工程において、 CF_4 を含む混合ガスを露出した前記積層体の部分に接触させることを特徴とする請求項17又は18記載の電子放出素子の製造方法。

5 20. 前記電子放出部形成工程は、

シリコン又はシリコンを主成分とする混合物若しくはその化合物からなる電子供給層を前記基板上に形成する電子供給層形成工程と、

各々が前記電子供給層上に接触する部分周りに影を形成する遮蔽体を前記電子供給層上に形成する遮蔽体形成工程と、

10 前記電子供給層及び前記遮蔽体上に絶縁体を堆積させ、絶縁体の薄膜からなる絶縁体層を、前記遮蔽体下の接触する部分周囲の前記絶縁体層の膜厚が漸次減少する少なくとも1つの島領域となるように、形成する絶縁体層形成工程と、

前記絶縁体層上に上部電極を成膜して、前記島領域を電子放出部として形成する上部電極形成工程と、を含むことを特徴とする請求項17～19のいずれかに

15 記載の電子放出素子の製造方法。

21. 前記島領域の上部もしくは下部又は内部に炭素又は炭素を成分とする混合物若しくは炭素化合物からなる炭素領域を形成する炭素領域形成工程をさらに含むことを特徴とする請求項20記載の製造方法。

22. (補正後) 前記ブリッジ形成工程において、前記上部電極及び前記絶縁
20 体層を等方性エッチング法によって食刻し、隣接する前記電子放出素子の前記絶縁体層及び前記上部電極と一体となった前記絶縁体層の材料部分を含む前記ブリッジ部を形成し、前記貫通孔または前記切欠部において前記絶縁体層の材料部

分を含む前記ブリッジ部分を形成し、前記貫通孔または前記切欠部において前記絶縁体の材料部分からなる前記貫通孔の中心へまたは前記切欠部の内側方向へ向い張り出した底形状構造を形成することを特徴とする請求項20又は21記載の電子放出装置。

- 5 23. 前記遮蔽体は、各々が前記基板の法線方向に突出する支持部と前記支持部から前記基板に平行な方向に突出する主マスク部とを有するマイクロマスクであり、前記遮蔽体形成工程において、前記基板上に支持部材料層及び主マスク部材料層を成膜し、その上にフォトリソグラフィ法によって少なくとも前記電子供給層の一部分を露出せしめるレジストマスクを形成し、ドライエッチング法
10 及びウエットエッチング法によって、前記主マスク部及び前記支持部を順に食刻して、前記マイクロマスクを形成する工程を含むことを特徴とする請求項20～22のいずれかに記載の製造方法。

24. 請求項1～16のいずれかに記載の電子放出装置と、前記上部電極に真空空間を挟み略平行に対向する光電変換膜と、前記光電変換膜に積層された光
15 透過性電導膜と、前記光電変換膜及び前記光透過性電導膜を保持する光透過性の前面基板と、からなることを特徴とする撮像素子。

25. 前記真空空間に前記電子放出装置及び前記光電変換膜に接することなく配置されたメッシュ電極を有することを特徴とする請求項24記載の撮像素子。

- 20 26. 請求項1～16のいずれかに記載の電子放出装置と、前記上部電極に真空空間を挟み対向しかつ前記真空空間側の表面に配置された蛍光体層及び前記蛍光体層上に形成され前記上部電極に対向したコレクタ電極を有する光透過

性の前面基板と、からなることを特徴とする表示装置。

27. 前記蛍光体層に対応する複数の発光部からなる画像表示配列を有して

